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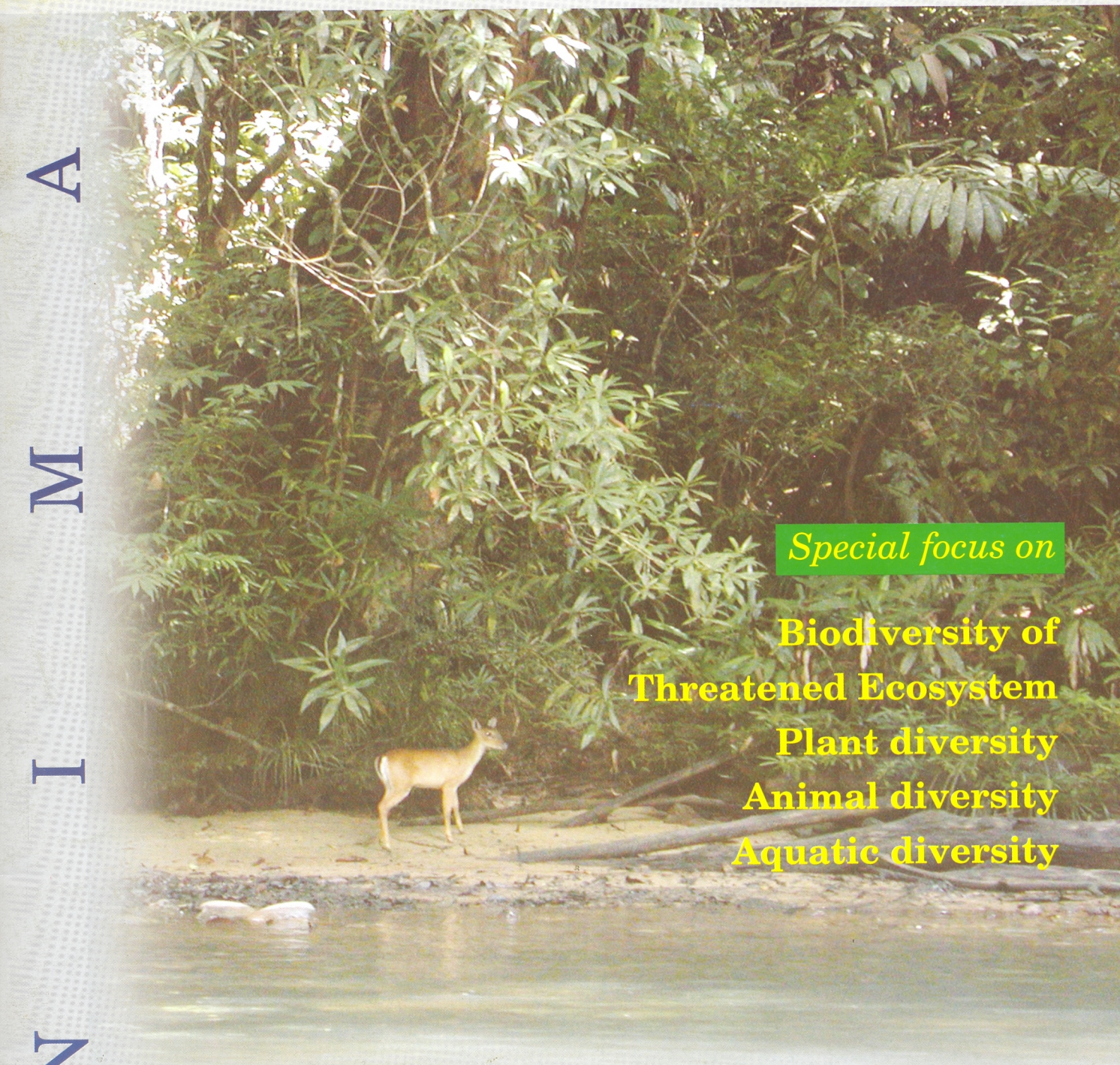


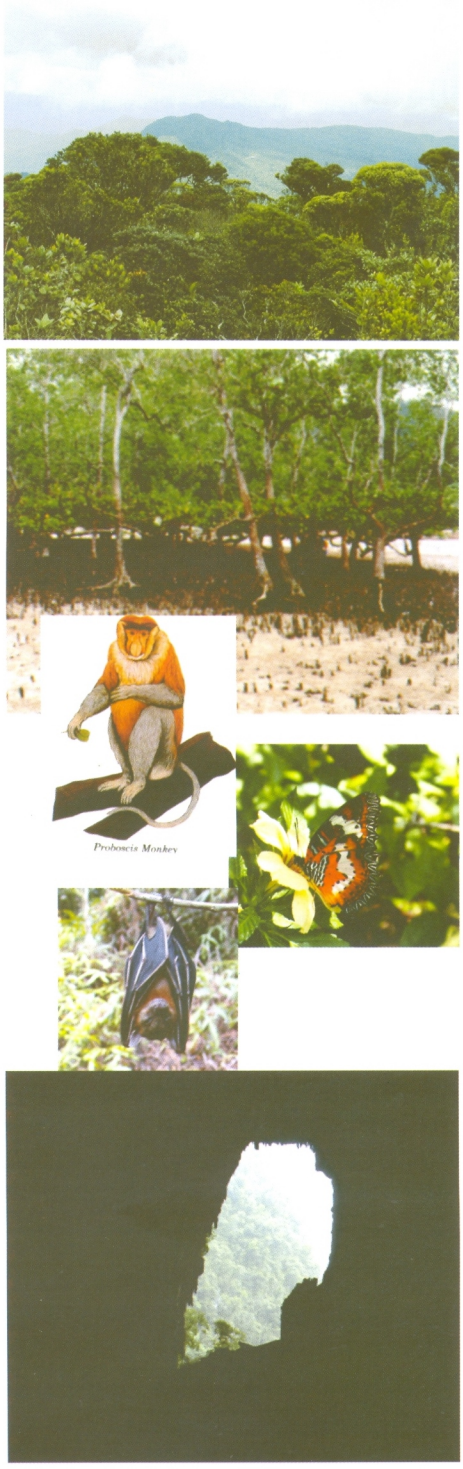
Special focus on

Biodiversity of
Threatened Ecosystem
Plant diversity
Animal diversity
Aquatic diversity

UNIVERSITI MALAYSIA SARAWAK
UNIMAS

Content

SARAWAK BIODIVERSITY PRELIMINARY SURVEY



Throughout the world, increasing interest is being expressed in environmental issues, largely as a result of the serious concern that is felt about the present state of both the local and global environment, and the predictions that have been made about future trends. During the last decade, much of this interest and concern has focused on the issue of biodiversity. Biodiversity components are highly complex and often poorly known and understood. For the purposes of the Global Biodiversity Assessment, biodiversity is defined as the total diversity and variability of living things and of the systems of which they are a part. This covers the total range of variation and variability among systems and organisms.

Situated on the north-western part of the island of Borneo with a total of land area of 124,499 km sq., Sarawak lies in one of the world's megadiverse areas. The vegetation is basically tropical rain forest, with a few exceptions along the coastal margin and the higher mountain regions. As a habitat "forest" totally dominates the rest in Sarawak. As is true for all tropical rain forests the tree diversity is tremendous and only rarely can one species be said to be dominant.

The aim of this project was to delimit the major ecological habitat divisions in Sarawak and to document the species of plants and animals to be found there. This first approach is to divide the state into 15 broad habitats, but to be most useful more detailed divisions are needed, and it is to be hoped that the project will be continued and expanded as a major joint effort. This compilation is intended as a basic reference on biodiversity research in Sarawak. Identification of most species, particularly the least studied fauna and flora such as fungi and invertebrates is difficult, and thus only scanty information on these biota is available.

Researchers
Fatimah Abang and Dennis S. Hill

Supporting grant
Unimas Fundamental Grant No. 01/24/30/2002(38)

Related publications

Hill, D.S. & F. Abang. 2003. Field Guide for the National Park. Proceedings of the International Conference on Biotourism: The treasures of Sarawak Rainforest: 118-125

Abang, F. and D.S. Hill (2004). Sarawak Biodiversity Survey 150pp. (in prep)

EVALUATION OF THE BIODIVERSITY OF THE KELABIT HIGHLANDS, SARAWAK

Gunung Murud lies in the interior uplands of northern Sarawak, roughly midway between Mt. Kinabalu in northeastern Borneo and Mt Tiban in the southwest. Standing at 2,423 m ASL, it is the highest mountain in Sarawak. With an area of ca. 1,645 sq km, it forms part of the Kelabit Highlands and flanks the Bario highlands, straddling part of the headwaters of the Baram, Tutoh and Limbang rivers. Because of its relative inaccessibility, the plant and animal life of these mountains has remained poorly known despite towering as the highest summit of Sarawak. An assessment of the biodiversity of selected groups of plants and animals was conducted during a two-week expedition to Mount Murud between 2-16 May, 2003. The project included sampling of various key groups by a multidisciplinary team of specialists in order to better understand and subsequently, create a database to manage and conserve its montane biodiversity. Taxic richness were measured and regional endemicity identified. Diversity and distribution as well as other ecological data of selected plant and animal taxa studied are being analyzed. Gunung Murud is characterised by high species diversity as well as endemicity. Information generated from these studies will be utilized in a project integrating nature conservation with the conservation of local cultures as well as sustainable utilization of the area's natural resources. Additionally, data generated from these studies will contribute to our knowledge on montane biodiversity, locally and internationally, and can be utilized in nature conservation projects as well as sustainable utilization of the natural ecosystem and its natural resources. Due to scarcity of previous work on Mount Murud, a large number of unidentified specimens remain, including a number of species that do not readily fit into currently recognised species. These include representatives of all the biota.

Researchers

Fatimah Abang, Indraneil Das, Cheksum Tawan, Mustapha Abd Rahman, Andrew Alek Tuen, Sepiah Muid, Mohd. Tajuddin Abdullah, Isa Ipor, Petrus Bulan And Charlie Laman.

Supporting grant

IRPA 08-02-09-1007 EA001

Related publications

Bulan, P., I.B. Ipor & C.S. Tawan 2003. Preponderance of bindang (*Agathis kinabaluensis* deLaubenfels) at Mount Murud Lawas, Sarawak Abstract: NARED, Unimas.

Abang, F. & I. Das. 2004. Biodiversity of Gunung Murud: An expedition to Sarawak's highest mountain. Abstract: National Seminar on Protected Areas. Proc. Institute of Biological Diversity, Bukit Rengit, Lancang, Pahang. Sept. 21-23. p 25

Abang, F. & A. Jackson. 2004. The Lepidopteran fauna of Gunung Murud, Sarawak. Abstract: National Seminar on Protected Areas. Proc. Institute of Biological Diversity, Bukit Rengit, Lancang, Pahang. Sept. 21-23. p 38

Das, I. 2005. A new species of *Polypedates* (Anura: Rhacophoridae) from Gunung Murud, Sarawak (Borneo). Herpetologica (in press).

THE BIODIVERSITY OF A PEATSWAMP FOREST IN SARAWAK

Peat swamp forests of Sarawak cover an area of about 1,657,600 hectares. Being one of the major forest formations in Borneo, it should be recognized not only as one of the important sources of renewable bioresources but also as a reservoir for the maintenance of biodiversity. This natural forest harbours a rich floral and faunal diversity with several species endemic to Borneo. Despite this, much of the systematic knowledge of biodiversity of peat swamp forest in Borneo is that of plant diversity, whereas limited information is available on the faunal component. However, among the animals, the vertebrate fauna of the peat swamp is substantially well documented. Conversely, no major systematic study on the invertebrate fauna has been carried out.

For the last decade, many of us waded through the peat swamp forest and its margin in the vicinity of the Unimas Campus in Kota Samarahan, sampling, observing and noting the ecology of a virtually unknown ecosystem. Based on our studies, 1600 individual trees of DBH ≥5.0 cm in a one hectare plot, representing 167 species of 37 families were recorded. We also reported twenty-four species of mammals representing seven orders and 14 families and a total of 679 birds representing 25 families and 67 species. Fifteen species of the birds mist-netted are listed as protected species under the Sarawak Wildlife Ordinance (1998). Within the reptile fauna, 17 squamate species were recorded, including 13 lizard species and four snake species. Overall, the invertebrate community with some specific exceptions represents a conservative assemblage of types that can be expected to recur in similar biotopes. The baseline data resulting from these studies could be used as fundamental units of basic inventory information that are crucial for a peat swamp forest biodiversity conservation planning and management in Sarawak. The protection and conservation of larger area of peat swamp ecosystems in Sarawak, in addition to the existing Maludam National Park should be seriously considered due to their uniqueness and the fact that they provide specific habitats for several plant species.

Researchers

Fatimah Abang, Indraneil Das, Cheksum Tawan, Isa Ipor, Mohd. Tajuddin Abdullah, Mustapha Abd Rahman, Andrew Alek Tuen, Sepiah Muid, Ramlah Zainudin, and Khairul Adha Abd Rahim

Related publications

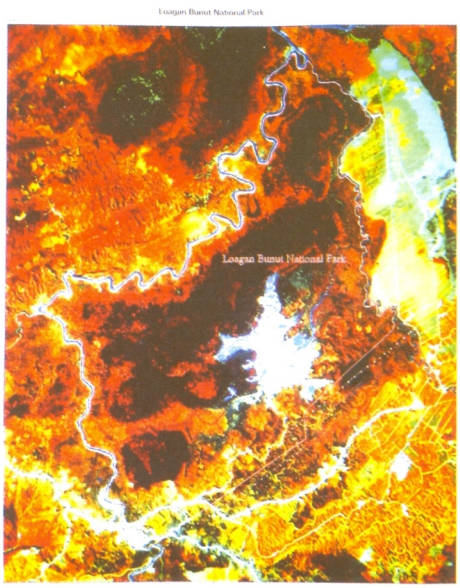
Abang, F. & C. Karim. 1999. Moth diversity in a secondary peat swamp forest in Kota Samarahan, Sarawak, Northwest Borneo. *In*: Proc. Malaysian Science & Technology Congress' 99: 282-289.

Tuen, A.A., & A. W. Darub. 1999. The diversity and abundance of understory birds in a peatswamp forest of Sarawak. *Malayan Nat. J.* 53(4): 287-294.

Ramlah, Z. 2002. Frog diversity at Sedilu Peat Swamp Forest Reserve, Sarawak. *Malayan Nat. J.* 56(23):217-223

Abang, F. & I. Das (eds). 2004. The Biodiversity Of A Peatswamp Forest In Sarawak. (in press)

THE BIODIVERSITY OF LOAGAN BUNUT NATIONAL PARK



In response to a global concern over the threats to wetland and the urgent need to enhance local awareness of the local people that exploitation of the natural resources inside and outside the park in the last 30 years has threatened the biodiversity and integrity of the park ecosystem, a multidisciplinary scientific expedition was mounted to Loagan Bunut National Park (LBNP) in 28 March – 12 April 2004. The aim of the expedition was to discover, study and document the physical, biological and socio-economic environment of LBNP. Funding for this expedition (RM200,000) was provided by Unimas through its Fundamental Research Grant. A total of 107 researchers took part in the expedition and they are mainly Unimas staff but also includes staff from several state government agencies, notably Sarawak Forestry Department, Sarawak Forestry Corporation, Department of Minerals and Goescience. Other participants come from FRIM, UPM and the UK.

The biodiversity component comprises 11 research projects which assessed the diversity of aquatic and terrestrial ecosystem. The terrestrial ecosystems assessed include peatswamp forest, mixed swamp forest, riverine forest, logged mixed dipterocarp forest and secondary forest. The components of animal diversity studied include fish, insects, reptiles and amphibians, birds and mammals while the plant research group focused on fungi, tree flora of peatswamp forest, and seed bank in riverine forest.

The researchers identified 131 species of fungi, 97 species of flowering plants, 70 species of fish, 27 species of reptiles, 18 species of frogs, 231 species of moths, 92 species of birds and 11 species of mammals. Abstracts of some individual projects appear in this volume and the full report will be published in a monograph on the environment of LBNP.

Supporting grant:
Unimas Fundamental Grants

Related publication:
Loagan Bunut Scientific Expedition, Final Report

MACRO-FUNGI DIVERSITY

Boletus sp.

Edible *Polyporus* sp.

Great diversity of macro-fungi is expected to exist in the tropical regions, such as in Sarawak. Factors that could contribute to the successful establishment of these fungi are their ability to exploit a wide range of substrates, especially of plant origins, having different behaviours and genetically easy to adapt to changes of environmental conditions. Samples of macro-fungi, which have different growth patterns, colours, sizes, structures and textures have been collected from forests in Sarawak however many of them have not yet been identified to the species level. Some of these fungi, such as species of *Pleurotus, Polyporus*, are edible. Several species of *Amanita*, which are poisonous and one species of *Amanita*, which is edible and locally known as kulat kasut, have also been found. *Microporus spp., Pycnoporus spp.* and *Trametes spp.* are among the common macro-fungi on decayed wood, and they also could cause damage in timber. *Ganoderma spp.* and *Amauroderma spp*. are also common in the forest and they are not only responsible for the decay of dead wood materials but also as pathogens in the forest trees. Several mycorrhiza fungi, such as of *Agaricus spp., Boletus spp.* and *Lacterius spp.*, which have a good association with plant to attain a better life for both, have also been identified. Many more macro-fungi present as the decomposer of plant materials with the aid of various types of enzymes have been identified.

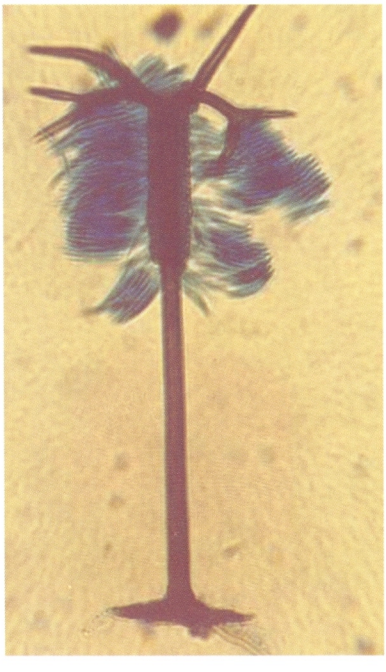
Researcher
Sepiah Muid
Faculty of Resource Science & Technology

Supporting grant
UNIMAS short grant

Related publication
Sepiah, M. (2004). Macro-fungi of Loagan Bunut.

MICRO-FUNGI DIVERSITY

Manispora sp.



Cryptophiale cucullata

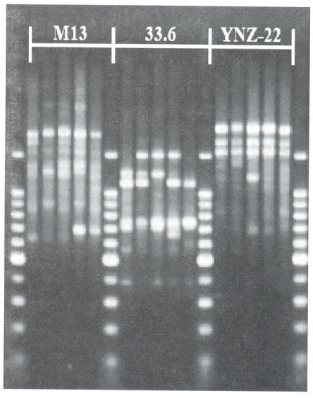
Diverse species of micro-fungi were present on the green leaves, senescent leaves (newly fallen leaves) and leaf litter collected in the forest. More than 150 fungal taxa consisting of 58 genera have been identified present on green leaves, senescent leaves and leaves litter collected from peatswamp forest at UNIMAS temporary campus, in Kota Samarahan, alone. The diversity of the fungi on senescent leaves was significantly higher than that of the green leaves or of the leaves litter. Species of *Botryodiplodia, Codinaea, Cryptophiale, Fusarium, Neottiosporella, Penicillium, Pestalotiopsis* and *Trichoderma* were the common fungi encountered on the leaves samples incubated in moist chamber. Of these, B. theobromae was the most frequently found fungus on the leaves. The fungus was more often found on the green leaves than on senescent leaves or on the leaves litter. Average percentage of occurrence of the fungus on leaves of the peat forest was 60.6 %. *Pestalotiopsis guepinii* was found mainly on senescent leaves. Although large number of fungal species was found on the leaves, the majority was present on less than of 5 % of the total samples examined.

Researcher
Sepiah Muid
Faculty of Resource Science and Technology

Supporting grant:
UNIMAS Fundamental Research Grant

Related Publication

Sepiah, M. and Roha, L (2000). .Micro-fungi of peat swamp forest in UNIMAS temporary campus. Proceeding 23rd Microbiology Society Symposium.



MOLECULAR TECHNIQUES FOR BELIAN CONSERVATION

Belian or its popular name, Borneo Ironwood, is the most famous and well-known durable hardwood timber tree of Borneo, which comes from the family Lauraceae. There are two species of Belian, i.e. *Eusideroxylon zwageri* and *Potoxylon malagangai*. Both species have a very close similarity in their vegetative characters except the wood structure. *P. malagangai* has lighter colour of wood and lower durability compared to *E. zwageri*. Thus, it is not easy to distinguish the two species based on their vegetative characters when in the field. To date, little genetic information is available on these valuable timber species, and therefore the belian must be studied thoroughly using molecular techniques to identify genetic variation within and among belian populations in order to conserve the rapidly declining belian populations in Sarawak. The characterization of genetic variation is central to the conservation of genetic diversity in natural or domesticated populations. Populations with little genetic variation are more vulnerable to the arrival of new pests or diseases, pollution, changes in climate and habitat destruction due to human activities or other catastrophic events. The inability to adapt to changing conditions greatly increases the risk of extinction. Moreover, the belian has been counted as one of the endangered species in Sarawak. The objectives of this study are to genotyping belian via PCR-based molecular marker techniques, and to develop species-specific genetic markers (sequence characterised amplified regions, SCARs) for identification of belian. The identification of individuals at species level constitutes one of the first basics in any effective conservation programme. Besides these, the genetic diversity of belian populations will also be determined using molecular marker techniques such as isoenzymes, Restriction Fragment Length Polymorphisms via PCR (PCR-RFLPs), Random Amplified Polymorphic DNAs (RAPDs), Directed Amplification of Minisatellite-region DNA (DAMD), Inter-Simple Sequence Repeats (ISSRs) and Simple Sequence Repeats (SSRs). The choice of molecular markers is largely dependent on the level of polymorphism to be detected and the genomic coverage of molecular marker.

Researchers

Ho Wei Seng (UNIMAS), Awang Ahmad Sallehin Awang Husaini (UNIMAS), Hairul Azman @ Amir Hamzah Roslan, Cheksum Tawan (UNIMAS), Isa Ipor (UNIMAS), Yii Ai Siew (UNIMAS)

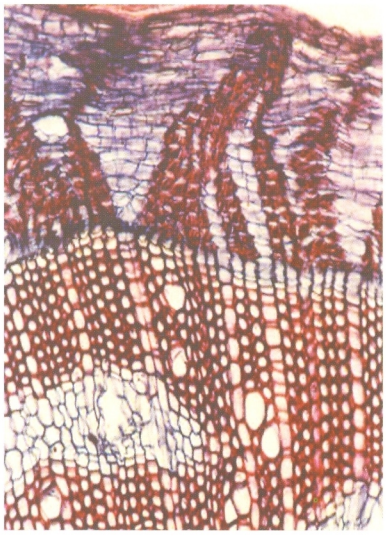
Supporting grant

UNIMAS Short-term Research Grant

Related publications

Ho, W.S., Yii, A.S., Cheksum, T. 2005. Genotyping of Borneo Ironwood (Belian) using polymerase chain reaction with the M13 universal primer. Paper to be presented at the 6th National Congress of Genetics, 12 – 14 May 2005, Kuala Lumpur.

SYSTEMATIC STUDIES AND CONSERVATION OF *AQUILARIA* SPP. (GAHARU) IN SARAWAK



Seeds of *Aquilaria beccariana*

Aquilaria spp. (ghaharu) is classified under the family Thymelaecaece. There are 15 species of *Aquilaria* reported in the tropical region and their distribution ranged include India; Burma; Mynmar, Indochina; China; and the Malesian region. About 12 species are found in the Malesian region namely *A. apiculata* Merr., *A. beccariana* Van Teigh. *A. brachyantha* (Merr.) Hall., *A. citrinaecarpa* (Elmer) Hall., *A. cumingiana* (Decne) Ridl., *A. filaria* (Oken) Merr., *A. malaccensis* Lamk., *A. microcarpa* Baill., *A. parvifolia* Quis., *A. rostrata* Ridl. and *A. urdanetensis (Elmer) Hall. Aquilaria* species produces incense wood or commonly known as gaharu, aloewood, agarwood, or garrowood. It is used for medicine, perfumery and incense. Gaharu is highly sought after and priced both for local use and in the international market particularly in the Arab countries. The extract of the *Aquilaria* wood contained sesquiterpene namely alfa-agarofuran, (-)-10 epi-gama-eudesmol and oxo-agarospirol. These compounds are the important components that produces the aromatic smell of the *Aquilaria* incense wood. Most of the *Aquilaria* species are found in the wild but indiscriminate harvesting of the trees for the incense will soon decreased it populations in their natural habitat of the tropical rainforests. Due to unreasonable felling for the gaharu, *Aquilaria* is now considered as threatened species. In Sarawak, all the *Aquilaria* species are protected under the state wildlife ordinance and *A. malaccensis* is included in appendix 11 of CITES. *Aquilaria* species are potential species for cultivation not only for its valuable fragrant woody material but wood production. Hence, this project focuses on the documentation, systematic and comparative studies, ecology, ecophysiology and gaharu formation of these species. The information is needed for sustainable production and species conservation.

Researchers

Cheksum S. Tawan (Unimas), Isa Ipor (Unimas) & Julaihi Abdullah (Sarawak Forestry Corporation).

Supporting grant

Unimas Fundamental Research Grant – 1/30/307/2002(44).

Related publications

Tawan, C.S. 2003. *Aquilaria cumingiana*.(Decne) Ridley. In: Lemmens , R. H.M.J. & Bunyapraphaphatsara, n. (Editors): Plant Resources of South-East Asia No 12(3), Medicinal and poisonous plants 3. Backhuys Publisher, Leiden, the Netherland. pp. 75-76.

Tawan, C.S. 2004. Thymelaeaceae - (3. *Aquilaria* Lam.). Tree Flora of Sabah & Sarawak. Vol.5. In: Soepadmo, E., Saw, L.G. & Chung, R.C.K. (editors) Forest Research Institute, Ampang Press, Sdn. Bhd. Kuala Lumpur pp. 433-484.

Cryptocoryne ciliata occurs in mudflats of brackish and saline water

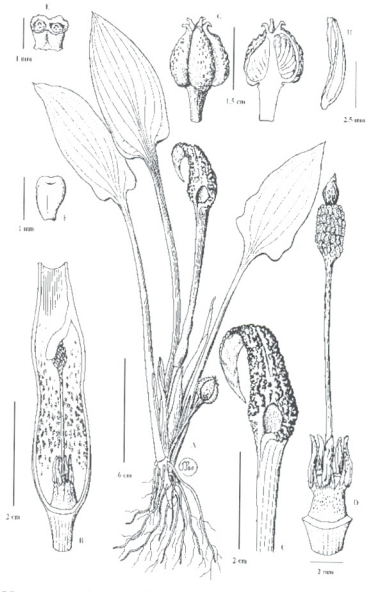


Illustration of the new species *C. tunzaidii*

Inflorescence of new natural hybrid discovered in Bau.

OCCURRENCE AND DISTRIBUTION OF CRYPTOCORYNE SPECIES IN SARAWAK

The study on occurrence and distribution of *Cryptocoryne* sp. (popular aquarium plant) was conducted in most parts of Sarawak. To date, a total of 127 occurrences of *Cryptocoryne* species from 274 rivers and streams throughout Sarawak were recorded. The common species with high number of records were *C. ciliata* (both variety ciliata and latifolia), varieties of *C. cordata* (formerly *C. cordata, C. zonata* and *C. grabowskii*), *C. longicauda, C. bullosa, C. ferruginea* and *C. pallidinervia. C. auriculata, C. keei, C. lingua, C. yujii* and *C. uenoi* were considered rare species with limited occurrence. The survey also discovered two new records that were *C. fusca* and *C. edithiae* for Sarawak. A variety of *C. purpurea* had been identified and needs further verification. A new species has recently been discovered and to be named as *Cryptocoryne tunzaidii*. This species is named after the late Tun Ahmad Zaidi Adruce, who was the first Chancellor of University Malaysia Sarawak and the fifth Governor of Sarawak. The name is given in honour of his vast contribution to the state of Sarawak and particularly to research development at UNIMAS during his lifetime. Environmental problems that threatened the population of *Cryptocoryne* species were also included in this study.

External collaborators to this project include Prof. Dr. Niel Jacobsens, Botany Section, Department of Ecology, The Royal Veterinary and Agricultural University, Denmark ; Dr Josef Bogner, Munich Botanical garden, Germany and Prof. Dr Mashor Manshor of USM.

Researchers

Isa Ipor (Unimas), Cheksum S. Tawan & Julaihi Abdullah (Sarawak Forestry Corporation).

Supporting grant

Unimas Fundamental Research Grant

Related publications

I..B. Ipor, C.S. Tawan and N. Jacobsons (2005). A new species of *Cryptocoryne* (Araceae) from Sarawak (in prep).

I.B. Ipor, C.S. Tawan & F.S. Tagor. 2004. Ecophysiology and growth patterns of *Cryptocoryne striolata Engler* at Sungai Stuum Toman, Bau, Sarawak. Journal of Bioscience. Vo1. 16.

I.B. Ipor, W.H. Ho, C.S. Tawan, M.S. Salmizan & Noryatimah, M. 2004. Ecology and DNA fingerprinting of *Cryptocoryne pallinervia* Engler Assessions using Polymerase chain reaction with M13 universal primer. Presented at the International Aroid Symposium,, Kuching, 24-27 Nov. 2004. (presenter)

I..B. Ipor, C.S. Tawan, J.Abai & N. Saupi. Occurrence and distribution of *Cryptocoryne* species in Sarawak, Malaysia. Presented at the International Aroid Symposium, Kuching. 24-27 Nov. 2004.

Simon, A. I.B. Ipor, C.S. Tawan & N. Saupi 2004. Morpholological characterisitics and growth pattern of two varieties of *Cryptocoryne ciliata* (Roxburgh) Schoo. in Sungai Sarawak, Kuching, Sarawak. Presented at the International Symposium on Aroid. 24-27 November 2004, Kuching.

SYSTEMATIC STUDIES AND CONSERVATION OF *GONYSTYLUS* SPP. (RAMIN) IN SARAWAK

G. bancanus in natural habitat at Loagan Bunut NP

Trunk of *G. bancanus*

Fruits and seeds of *G. forbessii*

The genus *Gonystylus* comprises about 30 species distributed from the Nicobar Island to Sumatra, Peninsular Malaysia, Borneo, Java, Sulawesi, the Philippines, New Guinea, Solomon Islands and Fiji. Most species are trees of lowland and mixed hill forest. However, *Gonystylus bancanus* or known locally as ramin occurred predominantly in the lowland peat swamp and mixed swamp forest at 0-100 m altitude above sea level. It is a fairly large tree reaching up to 50 m tall, 30-100 cm diameter, with rounded or cylindrical crown. The bole is straight sometimes fluted at base and without buttresses. The bark is often pale grey-brown and fissured. The wood was identified as a high utility, attractive and clean hardwood timber of medium density (530-785 kg/m3). It is extensively used for the manufacturing of furniture, cabinets, doors, counter tops, wall paneling, ceilings, pictures frames, curtain poles, moulding, plywood and numerous other indoors uses.

Due to over exploitation *G. bancanus* has been listed in Appendix 111 of CITES (Indonesia) and in 2001 and end of 2004 all of the *Gonystylus* species have been listed in Appendix 11. Hence with the growing concerned for this particular species and other *Gonystylus* species systematic and ecological studies are conducted especially for G. bancanus. It regeneration in the natural habitat is one of the priority research areas conducted.

The documentation of *Gonystylus* species supported by Tree Flora of Sabah and Sarawak project of FRIM has recently been published. The ecological and regeneration studies of *G. bancanus* is a collaborative work with Sarawak Forestry Department (coordinated by Mr Francis Chai) and Sarawak Forestry Corporation. Currently Liam Libor (SFC) is doing his postgraduate study in the above project - joint supervision by Dr Peter van Deer Meer of the ALTERA, Wageningen University & Research Centre, Netherlands.

Researchers

Cheksum S. Tawan (Unimas) and Isa Ipor (Unimas)

Supporting grant

Liam Libor is supported by Ramin project under the Joint Working Group Malaysia -The Netherland research grant.

Related publications

Tawan, C.S. 1999. A new species of *Gonystylus* (Thymelaeaceae) from Sarawak, Borneo. Botanical Journal of Linnean Society, 130: 65-68. Online at http://w.w.w.idealibrary.com.

Tawan, C.S., Yazid, B. & I.B. Ipor 2002. An ecological study of *Gonystylus bancanus* (Miq.) Kurz. At Sedilo Forest Reserved, Simunjan, Sarawak. Lau Seng, Gabriel Tonga Noweg, Kasing Apun, Lee Nyanti & Zani Assim (eds) In *Sustainable Management Of Natural Resources*, Natural Resources and Environmental Management Conf. Kuching, pp251 - 259.

Tawan, C.S. 2004. Thymelaeaceae - (4. *Gonystylus* Teijsm & Binn.). Tree Flora of Sabah & Sarawak. Vol. 5. In: Soepadmo, E. , Saw, L.G. & Chung, R.C.K. (eds.). Forest Research Institute, Ampang Press, Sdn. Bhd. Kuala Lumpur pp. 433-484.

SYSTEMATIC STUDY OF WILD *MUSA* SPP. (BANANA) AND VARIETIES IN SARAWAK

Borneo is considered as the center for wild *Musa* diversity and yet very few studies was conducted. Information on wild Musa spp. in Sarawak is still poorly known. Odoardo Beccari was the first botanist to collect and describe four species of wild *Musa* from Sarawak during his expedition from 1865 – 68, then followed by Mitsuru Hotta who studied wild *Musa* in northern region of Sarawak during his expedition from 1963 – 76. After that studies on wild Musa was neglected. The bananas have been exploited by man for food for millennia and is the staple crop in many regions of the world. It was one of the fruit-bearing plants to receive attention in the early development of agriculture more than 4,000 years ago, and become one of the first domesticated crops. The wild bananas are important, as they are genetic sources for cultivated bananas and plantains. A number of distinct groups of edible bananas today have been developed from wild species of *Musa*. The most widely distributed edible group are derived mainly from our wild species, known as *Musa acuminata*. However, the main threats today is that cultivars might be extinct within 50 years time as they are not resistant enough to the banana's diseases such as Panama disease (cause by the *Fusarium oxysporum*), Sigatoka disease (caused by *Mycosphaerella musicola*), Moko disease, banana mosaic, etc. As such the documentation, systematics studies and collections of living materials of the wild bananas are important, as they will provide ample of genetic resources use to produce new cultivars resistant to the current widespread banana diseases and improve cultivars for commercialization.

We initiated a systematic studied of wild *Musa* based on the anatomy and field morphological characters. The main objective of this study is to document all the wild *Musa* species in Sarawak and hence to produce good information which might be very useful for further research. Current research has shown that Sarawak has a great number of wild *Musa* species with certain species have high number of varieties.

Researchers

Cheksum Tawan (UNIMAS) Isa B. Ipor (UNIMAS) and Meekiong Kalu - currently registered as a postgraduate student of FSTS, UNIMAS).

Related publications

Hakkinen, M. & Meekiong, K. (2004). A new species of Musa from Borneo. *Systematics and Biodiversity* 2 (2): 1 – 5 (in press)

Hakkinen, M. & Meekiong, K. (in press). *Musa borneensis* Becc. (Musaceae) and its intraspecific taxa in Borneo. *Acta Phytotaxanomica Et Geobotanica.*

DIVERSITY OF *SCAPHOCHLAMYS* BAKER (*ZINGIBERACEAE*) IN SARAWAK

Zingiberaceae (ginger family) is a diverse and fascinating group of monocotyledonous herbs. These plants are represented throughout the tropical and subtropical regions, but the main centre of diversity is in Asia. The genus *Scaphochlamys Baker*, consisting of about 30 species is distributed from southern Thailand to the whole of Peninsular Malaysia and some parts of Borneo with the diversity being centered in Peninsular Malaysia. From 30 species recorded in the regions, only about five species recorded from Sarawak namely *S. reticosa, S. argentea, S. polyphylla, S. petiolata, S. aff breviscapa*. Most of the species described are distributed in western of Sarawak. To date, there are at least five more new species of *Scaphochlamys* that need to be described and identified. However, on going research on this genus shows that there are a lot more *Scaphochlamys* species in Sarawak. Lack of published reports on *Scaphochlamys spp* makes this study as essential as to start of the database on the information collected. For future studies, propagation and maintenance of living germ plasm will be conducted in green house at Unimas.

Researchers
Aida Shafreena Ahmad Puad, Khatijah Hussin (UKM) and Peter C. Boyce (Malesiana Tropicals)

Supporting Grant
Unimas Fundamental Research Grant: 01(102)/454/2004(191

Related publications

Hussin,K.H, Aida-Shafreena, A.P., Choong, C.Y. & Ibrahim,H. 2002. Systematic studies on *Scaphochlamys* species (Zingiberaceae). 3rd *Symposium on the family Zingiberaceae*, Khon Kaen, Thailand, July 7-12 2002.

Aida-Shafreena, A.P., Hussin,K.H, Choong, C.Y. & Ibrahim,H. 2002. Filogeni molekul *Scaphochlamys* Baker (Zingiberaceae) berdasarkan jujukan nukleotida ITS1 dan ITS2. *Prosiding Seminar IRPA RMK-7, Jilid II*. 487-490.

Aida Shafreena Ahmad Puad & Khatijah Haji Hussin (2000). Comparative leaf anatomy on several species of *Scaphochlamys* (Zingiberaceae) from Malaysia. *IRPA-7 Seminar*, Malacca Oct, Vol. II, 661-663.

QUANTIFYING THE DIVERSITY OF AVIFAUNA OF LOAGAN BUNUT NATIONAL PARK

The avifauna diversity in LBNP is abundantly rich and diversified, as depicted by the 92 bird species and 181 individuals observed or mist-netted, during the short period of our 10-day sampling. One species of totally protected bird, the Asian black hornbill *(Anthracoceros malayanus)* was also observed. In terms of species diversity for the three study sites, generally the fruit orchard (FO) was the most diversified, followed by mixed dipterocarp forest (MDF), with peat swamp forest (PSF). Testing for significant differences yield the hypothesized expectations that PSF bird diversity was significantly different from FO and MDF, respectively. However, there was no significant difference between FO and MDF bird diversity. Ecologically, the presence of avifauna in LBNP has initiated an interaction between the birds and plants, as they are the contributors to the plant biological life by pollinating flowers and dispersing seeds to other places. LBNP is an almost perfect breeding-place for avifauna during the birds mating season. In addition, the lake itself supports water bird species, like the oriental darter *(Anhinga melanogaster)* or commonly known as snakebirds, lesser adjuntant stork *(Leptoptilos javanicus)*, storm's stork *(Ciconia stormi)* and lesser fish eagle *(Ichthyophaga humilis)*. These birds can be categorized as the 'flagship' of LBNP. Overall, the bird community in LBNP acts as good indicators of the general condition of the LBNP ecosystem. Hence, it is important to protect the natural habitat of the area to support the avifauna diversity, especially the endangered species.

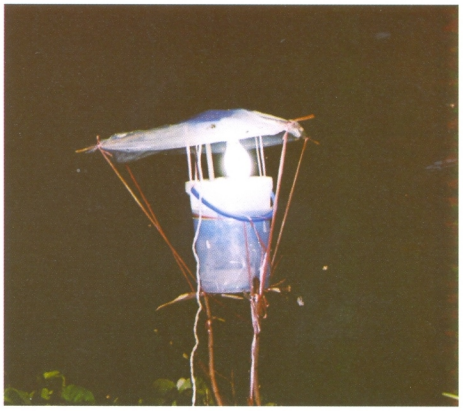
Researchers:
Charlie. J. Laman, Dancy. F. A. Gawin , and Mustafa Abdul. Rahman, *Faculty of Resource Science & Technology*

Supporting grant:
Unimas Fundamental Grant No. 01(93)/440/2004(177)

Related publication:

Laman C. J., D.F.A. Gawin, and M.A. Rahman (2005). Quantifying the diversity of Avifauna in Loagan Bunut National Park. *Proceedings of Loagan Bunut National Park Diversity Seminar.(Accepted for publication).*

QUANTIFYING DIVERSITY OF MACROMOTH IN LOAGAN BUNUT NATIONAL PARK



The study of Macromoth diversity was undertaken from 28 March to 11 April, 2004 at Loagan Bunut National Park (LBNP). Two sampling sites were selected, site 1 in the peat swamp forest, and site 2 in a mixed swamp forest. Modified Pennsylvanian light traps were employed, for a total effort of 16 trap nights. A total of 1156 individuals, comprising of 231 species from 10 families of macromoths were collected.

Simpson's index (using its inverse function) show a high index of almost 1.0 depicting a high diversity measure and indicating that the common species are very much abundant. The Shannon-Weiner index (H', using its exponential function) and the Brillouin 's index (H) both have indices more than 6.0, indicating a high diversity measure but a lack of emphasis on the rare species. Test of significant difference using Zar (1996) 's modified t-test indicated the expected hypothesis of a very significant difference between the peat swamp forest site and the mixed swamp forest site. Results also indicate that Noctuidae and Geometridae are predominant in Loagan Bunut, which are among the most diverse families of moths in Borneo. However, Cossidae and Saturniidae has the least number of species and individuals sampled from the study. About a quarter of all species sampled are singletons. The most abundant species collected was *Leucoma impressa* (family Lymantridae).

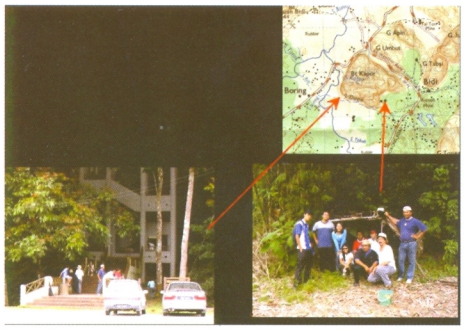
Researchers:
Charlie. J. Laman (Unimas), Fatimah Abang (Unimas) Paulus Meleng (SFC) and Ngumbang. Juat (Unimas)

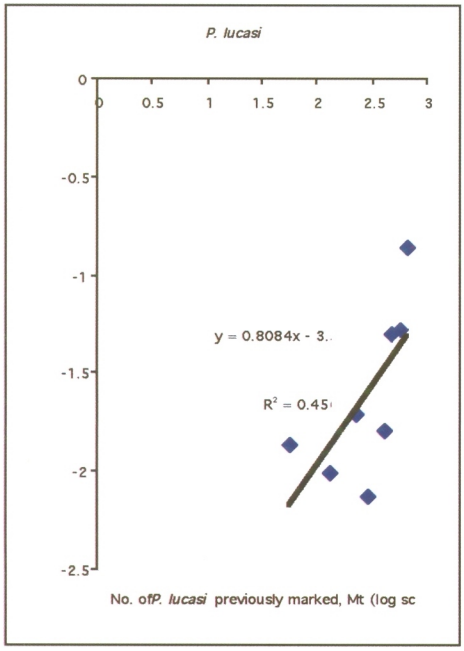
Supporting grant:
Unimas Fundamental Grant No. 01(93)/440/2004(177) and SFC traveling grant.

Related publication:

Laman C. J., F. Abang , P. Meleng and N. Juat (2005). Quantifying diversity of macromoth in Loagan Bunut National Park. *Proceedings of Loagan Bunut National Park Diversity Seminar.(Accepted for publication).*

POPULATION SIZE ESTIMATION OF *PENTHETOR LUCASI* (DUSKY FRUIT BAT) IN THE WIND CAVE, BAU, SARAWAK





Precise estimation of population size is essential for understanding the dynamics and structure of natural populations, as well as for assessing conservation status. A study was done in Wind Cave, Bau from October 14th to October 22nd, 2003, to estimate the population size of *Penthetor lucasi* (Dusky Fruit Bat). Throughout this study, 765 individuals of P. lucasi were captured and from these, a total of 27 individuals were recaptured. Due to the nature of the locality and the sampling methods used, it was initially assumed that the population of *P. lucasi* in Wind Cave was a closed population. Three closed capture-recapture model estimators were applied in this study, namely, the Lincoln-Petersen model, the Schnabel model, and the Schumacher-Eschmeyer model. The population size of *P. lucasi* analysed using the Lincoln-Petersen model was rather unrealistic and not convincing, as compared to the estimations calculated using the Schnabel, and the Schumacher-Eschmeyer estimators. Determination of the appropriate sample size led to a coefficient of variation of ± 0.2; only 40 % data were achieved. Further, upon testing for any violations against a closed population assumptions, the assumptions were clearly violated, leading to all closed population estimations as being invalid. The Tanaka model was subsequently computed: an estimated population size of 28338 individuals was achieved. In addition, if a 100% data were to be achieved, the population estimation should be 70845 individuals. This estimate will form the basis of our projected population estimation for *P. lucasi* in Wind Cave, Bau, Sarawak.

Researchers:
Charlie J. Laman, Mohd. Tajuddin Abdullah and Berapoi I. Puun, FRST,Unimas

Supporting grant:
Unimas Fundamental Grant No. 01(05)/267/ 2002(05) and 1(41)/321/2002(58)

Related publication:

Laman C. J., M.T. Abdullah and B.I. Puun (2005). Population size estimation of *Penthetor lucasi* (dusky fruit bat in wind cave, Bau, Sarawak. To be presented at Second Regional *Symposium on Environment and Natural Resource,22-23 March, 2005, UKM, Kuala Kumpur*

QUANTIFYING ALTITUDINAL DIVERSITY OF MOTH ASSEMBLAGES IN MOUNT SERAPI, SARAWAK

This research was done to quantify moth assemblages in terms of species diversity, along 3 chosen altitudinal sites at Mount Serapi, Sarawak. The 3 sites were at 200-300m, at 500-600m and at 800-900m above sea level, corresponding to lower mixed dipterocarp forest, mid-mixed dipterocarp forest and upper mixed dipterocarp forest, respectively. Modified Pennsylvanian light traps were used to trap the moths with 3 nights trapping per site using 2 light traps. Data collected showed a rich diversity of moth assemblages, characterized by high abundance of *Arctiidae, Geometridae* and *Noctuidae*. Simpson's and Shannon-Wiener non-parametric indices were calculated for both actual data and averaged data. Tests using Shannon-Wiener value and Zar's (1996) modified t-test, show a significant difference between site 1 and site 3, between site 2 and site 3, respectively. Apparently, moth diversity is significantly different between the lower mixed dipterocarp forest (200-300m) and the upper mixed dipterocarp forest (800-900m) and between mid-mixed dipterocarp forest (500-600m) and upper mixed dipterocarp forest (800-900m), respectively. Holloway (1984) had also depicted that at altitudes between 600m and 1000m above the sea level, the moth diversity is the highest.

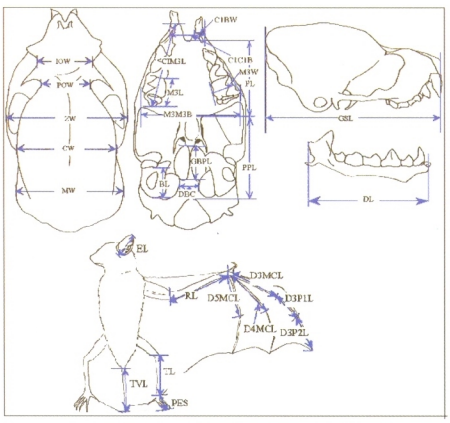
Researchers:
Charlie J. Laman, Fatimah Abang and Hanis Abdul Razak, *FRST,Unimas*

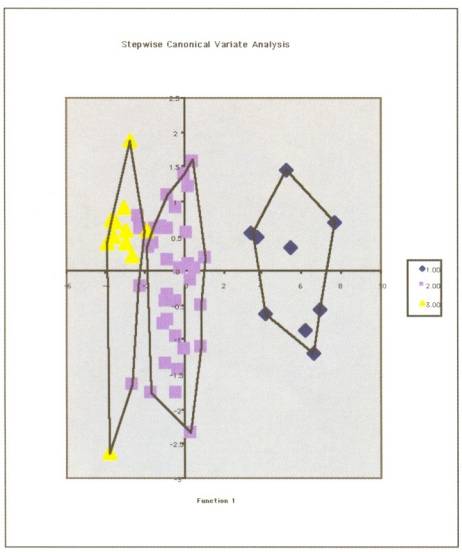
Supporting grant:
Unimas Fundamental Grant No. 1(41)/321/2002(58)

Related publication:

Laman C. J., F. Abang and H. A. Razak, (2004). Quantifying altitudinal diversity of moth assemblages in Mount Serapi, Sarawak. *Proceedings of Regional Conference on Ecological and Environmental Modeling (ECOMOD2004). School of Mathematical Sciences and School of Biological Sciences, USM*. Submitted.

MORPHOLOGICAL VARIATION IN THE GENUS *CYNOPTERUS* OF PENINSULAR MALAYSIA AND BORNEO





In Borneo, the genus *Cynopterus* consists of three species, namely, *C. brachyotis, C. sphinx* and *C. hosfieldii*. All three species are morphologically similar with unresolved status in *C. brachyotis* and the many names that surround the genus (Corbet and Hill, 1992). The species *C. brachyotis* has two intermediate forms with the larger form found in forest edge or open area and smaller form found in tall forest but because of both forms sometime overlap in their habitat and morphology, the taxonomic situation is unresolved (Payne et al., 1998; Abdullah, 2003). Field sampling across the range was conducted in Peninsular Malaysia, Sabah and Sarawak for Megachiroptera (fruit bats) to cover the full range of the genus *Cynopterus* and species within it. We set up 10-20 units of mist nets to capture bats in forests and open areas for at least three consecutive nights. Samples taken from the zoological museum at Universiti Malaysia Sarawak were also assessed for the purpose of the study. A total of 57 adult specimens of *Cynopterus* were examined morphologically and a total of 28 morphological (skull and body measurements) characters were measured from the bats with reference to Kitchner *et al.* (1993). All 28 external morphological and skull measurements were subjected to multiple regression, discriminant function analysis (DFA) and canonical function analysis following Manly (1989) in order to differentiate the species within the genus *Cynopterus* and within the cryptic *C. brachyotis* populations. The research is on-going.

Researchers:
V.K. Jayaraj, C. J. Laman and M. T. Abdullah
Faculty of Resource Science and Technology, Unimas

Supporting grant:
IRPA 09-02-09-1022-EA001 (M.T. Abdullah)

Related publication:

Jayaraj V.K., C.J. Laman and M.T. Abdullah (2005). Morphological variation in the genus *Cynopterus of Peninsular Malaysia and Borneo. Proceedings of Regional Conference on Ecological and Environmental Modeling (ECOMOD2004). School of Mathematical Sciences and School of Biological Sciences, USM.* Submitted.

SYSTEMATICS AND DISTRIBUTION OF THE BUTTERFLY (*RHOPALOCERA*) FAUNA OF SARAWAK

Butterflies are among the best-known insects and they are perhaps the best group of insects for examining pattern of terrestrial biotic diversity and distribution. They also have a favorable image with the general public. Hence, they are an excellent group for communicating information on science and conservation issues such as diversity, and as a taxon qualifies as a bioindicator group. In an attempt to study the systematics and distribution of the butterfly fauna of north-western Borneo, existing voucher specimens dating from the 1800's until 2003 from the Sarawak Museum, Forest Research Centre and the Universiti Malaysia Sarawak Insect Collections were studied. Five families are represented, namely Papilionidae, Pieridae, Nymphalidae, Lycaenidae and Hesperiidae. Results from this study show that a wide range of forests in Sarawak is characterized by the presence of a large proportion of Nymphalidae, Lycaenidae and Hesperiidae, which are among the most diverse families of butterfly in Borneo. Overall, the butterfly fauna of Sarawak could either be classified into widely distributed species or rare species which were only distributed in restricted biotopes within Sarawak. A database of the 731 species preserved as voucher specimens has been created and a systematic account of most of the species, as well as an image bank of all specimens have been compiled. Historical collections of organisms provide extremely important baseline information on how the range, abundance and form of species may change over time. Knowledge of species diversity of this fauna is fundamental in providing the basis for further ecological research. Certain species flag changes in biotic or abiotic conditions, and they should reflect the quality and changes in environmental conditions as well as aspects of community composition.

Researcher
Fatimah Abang and Dennis S. Hill,
Faculty of Resource Science and Technology

Supporting grant
Unimas Fundamental Grant No: 01/22/299/2002(36)

Related publications

Abang, F. 2002. First Record of *Appias nephele* Hewitson (Lepidoptera: Pieridae) for Borneo. *The Butterfly Society of Japan – Butterflies* No. 31. 57-58.

Abang, F. & D.S. Hill. (2003). *Doleschallia bisaltide* Fruhstorfer (Lepidoptera: Nymphalidae) in Sarawak. The Butterfly Society of Japan – *Butterflies* No.36: 16-17.

Abang. F. 2003 Entotourism and Butterfly Conservation in Sarawak. Proceedings of the International Conference on Biotourism: The Treasures of Sarawak Rainforest: 104-117

Abang, F. and N.M. Fauzi. 2004. Butterflies Of Gunung Pueh-Berumput Ridge SERANGGA, Vol. 9(1-2): 119-126

Abang, F.and N.M. Fauzi. 2004. On an Aberrant *Pathysa (Paranticopsis) delessertii delessertii* (Guérin-Méneville) (Lepidoptera: Papilionidae) from Borneo. SERANGGA, Vol. 9(1-2): 127-130

Abang, F. 2004. Fluttering Beauties. Sarawak Discovery Issue No. 1. The Sarawak Press. p.13

SYSTEMATICS AND DISTRIBUTION OF THE LONGHORN BEETLES (*CERAMBYCIDAE*) OF SARAWAK

The family *Cerambycidae* (Coleoptera) consists of beetles that attack dead trees or fallen logs and are of economic importance because their wood--boring larvae are destructive to plants and freshly cut logs. In Sarawak, the longhorn beetles are known to attack valuable timber from the family *Dipterocarpaceae, Thymelaeaceae, Sapotaceae* and *Leguminosae*. Thus, these beetles are regarded as pest to our wood-based industry. Wallace (1962) described Sarawak as the most prolific spot for collecting longhorn beetles, where he captured 80 species in 15 days and 120 species within a month. According to Linsley (1959), *Chlorophorus* (Clytanthus) annularis were seen in swarm on Mt. Penrisen and Demonax species, a greyish black-banded beetle, was the commonest of all cerambycine in Kuching. As compared to the surrounding regions, taxonomic work on the longhorn beetles of Sarawak is still lacking. The primary objective of this study was to evaluate the taxonomic status and the diversity of these beetles in Sarawak. Based on this study, the family *Cerambycidae* of Sarawak could be classified into four subfamilies, namely *Prioninae* (6%), *Cerambycinae* (25%), *Lamiinae* (68%) and *Lepturinae* (1% excluding 2 species of Disteniidae). The majority of the known species from the subfamily Cerambycinae were collected by A. R. Wallace during his extensive exploration in the Malay Archipelago which were described by Pascoe (1869). These include 72 holotypes collected in Sarawak. Despite the discovery of new species in recent years, about 65% of all the species listed were never recorded ever since. This systematic study would undoubtedly contribute to the knowledge of biodiversity in Borneo as well as towards insect conservation in Sarawak.

Researchers

Fatimah Abang and Eduard Vives (Dept of Entomology and Biodiversity, Museu de Zoologia de Barcelona, Spain)

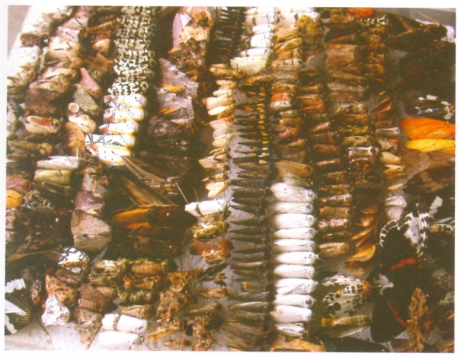
Related publications

Abang, F. 2003. A checklist of the longhorn beetles from Sarawak. SERANGGA 8 (1 & 2): 24-30

Vives, E. & F. Abang. 2003. Notes on the Lepturinae (Coleoptera: Cerambycidae) of the Sarawak Museum insect Collection. The Sarawak Museum Journal. LVIII(79):245-249

Abang, F. & Vives, E. 2004. Two new species of Callichromatini from Sarawak, South-western Borneo (*Coleoptera:Cerambycidae*) LAMBILLIONEA, CIV: 233-237

SYSTEMATICS AND ECOLOGY OF MOTH (*HETEROCERA*) FAUNA IN SELECTED PROTECTED AREAS IN BORNEO



Moths (*Lepidoptera: Heterocera*) are one of the highly plant-dependent groups of insects and form a rich component of the Bornean rain forest fauna. Compared to the other megadiverse insect groups, the larger moths of Borneo, in particular, are taxonomically well known and relatively easy to identify. They also show sensitivity towards environmental changes due to their habitat preference, and this makes them a suitable biological indicator group in biodiversity assessment and documentation. Furthermore, the vast majority of both the macro- and micro-moths are nocturnal and their response to light provides a very convenient method of sampling by using the ultra-violet or mercury vapour light trap.

This project aims at studying the macromoth systematics and ecology in various vegetation types and altitudes from the forests of selected protected areas in Borneo. Sampling sites include selected forests from various lowland areas (mixed dipterocarp, kerangas, limestone and alluvial forest) and montane (upper and lower) areas, ranging in altitudes from 50m to 2360m a.s.l. Different types of vegetation and altitude will give different values of macromoth diversity and assemblages. For instance results from our past study in a degraded secondary peat swamp forest in Samarahan show that the William's Alpha diversity index (160±7; 95% confidence range) was lower than that of a lowland mixed hill dipterocarp forest in Poring, Sabah (348.56±12.56; 95% confidence range). For an undisturbed Bornean forest, the typical range for the William's Alpha index falls between 200-400. Species composition will also vary from one forest type to another although family composition may be similar.

Researchers

Fatimah Abang, Charlie J. Laman (Unimas) and Prof Kyu-Tek Park Center for Insect Systematics, Kangwon National University, Korea).

Supporting grant

UNIMAS Fundamental Grants No: 123/98 (12) and 1(41)/321/2002(58).

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Abang, F. and C. Karim. 1999. Moth diversity in a Secondary Peat Swamp forest in Kota Samarahan, Sarawak, Borneo. Proceedings of the Malaysian Science and Technology Congress: Environmental and Renewable Resources. 282-289.

Abang, F. & Catherine Ak Karim 2003. A checklist of moths (*Lepidoptera: Heterocera*) from Kota Samarahan, Sarawak. SERANGGA, 8 (1 & 2): 13-23

Karim, C. & F. Abang. 2004. Macromoths of the Bau Limestone Area. Sarawak Bau Limestone Biodiversity, The Sarawak Museum Journal Special Issue No. 6: 365-389

Laman C. J., F. Abang and Razak, H A. (2004). Quantifying altitudinal diversity of moth assemblages in Mount Serapi, Sarawak. Abstract: in Regional Conference on Ecological and Environmental Modeling (ECOMOD2004). Universiti Sains Malaysia.

Kyu-Tek Park, K. Sugisima & F. Abang. 2005 Genus Thubana Walker from Malaysian Borneo, with Descriptions of Seven New Species (*Lepidoptera, Lecithoceridae*). J. Asia-Pacific Entomol. 8(1):1-11

PATTERNS OF VARIATION IN THE MOUNTAIN BLACKEYE (*CHLOROCHARIS EMILIAE*) IN BORNEO

Mountain Blackeye

Mountain Blackeye (*Chlorocharis emiliae*) has intrigued many ornithologists in the 1950's to investigate and clarify the distribution of this high montane resident throughout the Borneo Island. The bird is endemic to Borneo Island and is the commonest bird between 1600- 2100 m on Mount Kinabalu and Mount Trus Madi (above 1250 m) in Sabah; Maga mountains, Tama Abo Range, Mount Mulu and Mount Murud (above 1600 m), Poih Range in Sarawak and lastly Mount Nyiut, in Kalimantan, Indonesia. Five subspecies of this bird is recognized. The division of mountain blackeye into five subspecies has triggered many questions such as how the species diverged morphologically, when did it occur and what factors contributed to the subspecific variation of that species. These questions could be answered scientifically by applying molecular and numeric morphological analysis to specimens collected throughout its range. To date, no molecular studies and analyses of external morphology characters have been conducted on this species. Fieldwork at Mount Kinabalu and Gunung Murud has yielded several specimens for molecular and morphological analysis. Unfortunately the fieldwork at the summit of Gunung Pueh, Berumput and Kranji (near Sematan) has failed to capture the birds although these were spotted in the area. This research is on-going.

Researchers:
Dancy. F. A. Gawin and Mustafa Abdul. Rahman,
Faculty of Resource Science & Technology

Supporting grant:
Unimas Fundamental Grant No. 248/2001(7)

DIVERSITY AND DISTRIBUTION OF RODENTS IN DISTURBED FOREST OF SARAWAK

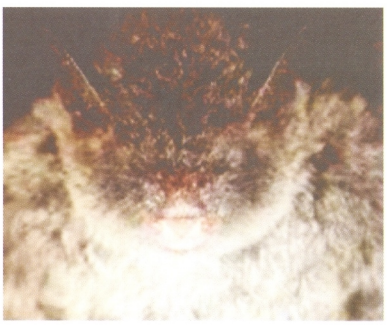
Rodents are among the most common and diverse group of mammals in the Animal Kingdom. The reason for their success lies in their ability to adapt well to changing environment and indeed are found in a variety of habitats ranging from primary forest to city streets. Other than performing ecological functions such as seed dispersal, many species of rodents are important in the socio-economy of humans as agricultural pests and carriers of disease. As forest are being cleared and habitats changed, we suspect the pattern of distribution and abundance as well as the diversity of rodents will change correspondingly. In our research, we studied the composition, diversity, distribution and abundance of rodents in disturbed and less disturbed secondary forest. Our results show that rodent diversity tend to be higher in more disturbed habitats compared to less disturbed habitats. However certain species of rodents, for example Giant Long-tailed Rat (*Leopoldamys sabanus*) and Giant Squirrel (*Ratufa affinis*), are found only in old secondary forest and primary forest.

Researchers:
Andrew Alek Tuen

Supporting grant:
Unimas Fundamental Grant No. 256/2001(15)

BIODIVERSITY AND CONSERVATION OF BATS IN THE BERUMPUT-PUEH MOUNTAIN COMPLEX, SARAWAK

The rare *Kerivoula papillosa* found in Gunung Berumput



The rare Orange tube-nose bat *(Murina cyclotis)* found at Pueh

The Berumput-Pueh mountain complex is located about 100 km to the west of Kuching. It runs in the north-south direction for about 20 km along the Sarawak-Kalimantan Barat border and is dominated by two peaks, Gunung Berumput (4877 ft) and Gunung Pueh (4235 ft). Natives from both sides of the border are known to hunt and extract forest products from the jungle. Now most of the forest has been logged and at the lower elevation, farmed. Bat biodiversity was compared between the Berumput highland and Pueh lowland with the mountainous complex on the western Sarawak-Kalimantan Barat border. Standard mist-nets were deployed at the foot of Gunung Pueh in October 2001 and in May 2002 in Gunung Berumput. The cumulative species curves have shown of adequate sampling effort carried out in both sites. A total of 179 individuals from five families and 17 species were caught during this study. The lowland of Gunung Pueh is more diverse in bat diversity (H' = 0.712) compare to the upland Berumput and the Short-nose Fruit Bat, *Cynopterus brachyotis*, was the most abundant species. *Murina cyclotis* and *Rhinolophus* arcuatus are new distribution records for species of bats in Sarawak. The high diversity of bats in the disturbed lowland area might be related to the habitat, structural diversity and tree phenology where large numbers of species were captured in Pueh. The low capture of microchiroptera species may be due to insect bats using their echolocation system to detect and avoid mist nets. Some management recommendations are made for a long term conservation of bats in the region.

Researchers:
M.T. Abdullah, Abang Arabi Abang Aimran and Andrew Alek Tuen

Funding:
Unimas Research grants

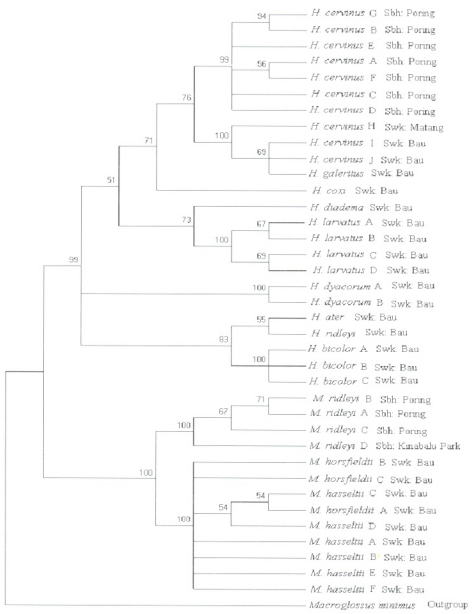
Related Publications:

Abdullah, M.T., M.A. Rahman and L.S. Hall. 1996. New records for bats in Sarawak, Malaysia. Malayan Nature Journal, 50:365-367.

Abdullah, M.T., L.S. Hall, M.A. Rahman, Besar Ketol, Wahap Marni &and Isa Sait. 2000. A note on the rare Pipistrellus vordermanni in Sarawak, Malaysian Borneo. Malayan Nature Journal, 54(4): 375-376.

Aimran, Abang Arabi bin Abang. 2002. Kepelbagaian kelawar di kaki Gunung Pueh, Sarawak. Projek Ilmiah BSc, Program Sains dan Pengurusan Hidupan Liar, Universiti Malaysia Sarawak, Kota Samarahan.

PHYLOGENETIC RELATIONSHIP AND STATUS OF *HIPPOSIDEROS* AND *MYOTIS* BASED ON MTDNA 16S RRNA SEQUENCES IN BORNEO



A 50% strict consensus tree base on Neighbor-Joining (NJ) tree obtained for bootstrap replication (n=1000) with Macroglosus minimus as outgroup. Numbers above are bootstrap values (>50% of 1000 iterations). Species codes: H.= Hipposideros, M.= Myotis. Location codes: Sbh= Sabah, Swk= Sarawak.

Insectivorous bats (*suborder Microchiroptera*) or microbats are also known as 'echolocation bat' because they develop the ability to use echolocation to navigate and to find food. Microbats are also well known as significant predator of nocturnal insect and act as natural biocontrol of pest. Despite their contribution and importance to the ecosystems, phylogenetic studies among the microbats species and their place in the mammalian tree of life have been until recently, poorly studied. Bornean insectivorous bats (*suborder Microchiroptera*) comprise seven families within which consist of 75 species. To date, classification of Bornean microchiroptera has been based on morphological characterization, and has not been established via molecular systematic . We have previously reported on an updated distribution and abundance of microchiroptera based on field survey performed in six forest regions in the Malaysian Borneo states of Sabah and Sarawak. Our reports revealed the widespread distribution of *Hipposideros dyacorum* and *Myotis ridleyi*. In this study, we demonstrated the successful utilization of 16S mitochondrial ribosomal ribonucleic acid (mt rRNA) in the delineation of phylogenetic status of the genus *Hipposideros* and *Myotis* found in Sabah and Sarawak. Our findings clarified and revalidated six taxonomic status of the genus *Hipposideros*. The previously ambiguous inclusion of *H. galeritus* into the *H. cervinus* taxon was re-demonstrated. Within the Myotis clade our data indicates close genetic relationship between *M. horsfieldii* and *M. hasseltii*, and an independent grouping of *M. ridleyi*. Although the specific inter-relationship among the genus studied remains partially resolved, our findings present novel molecular phylogenetic status of two Bornean microchiropteran taxa. This will represent important baseline reference for future studies on the precise phylogenetic relationship of Bornean insectivorous bats.

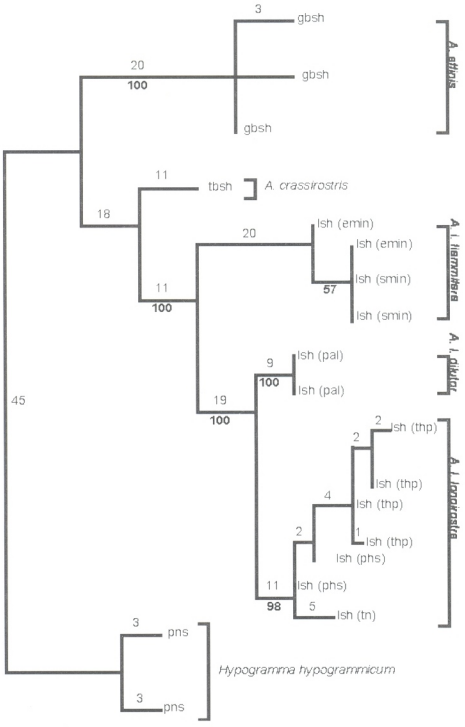
Researchers:
Imelda Vivian Paul, Edmund Ui-Hang Sim and M. T. Abdullah

Funding:
Unimas Research grants

Related Publications:

PAUL, I. V., SIM, E. U. H., ABDULLAH, M. T., TUEN, A. A., KETOL, B., MARNI, W., & SAIT, I. 2003. Phylogeny and Ecological Studies of Insectivorous Bats (*Suborder Microchiroptera*) of Borneo: Abundance, Distribution and Molecular Systematics. In Abstracts of the Natural Resource, Environment and Development (NARED) 2003 Conference, Kuching Sarawak.

PATTERNS OF GENETIC VARIATIONS IN THE LITTLE SPIDERHUNTER (ARACHNOTHERA LONGIROSTRA) IN SOUTHEAST ASIA



The theory of plate tectonics has revolutionised the understanding of the geological and biogeographic processes in the Southeast Asian region. These concepts of continental movements which were developed about 30 years have been used with much success to reassemble in general terms the palaeogeographical history of parts of Southeast Asia. Vicariant events associated with basin formation and collision events between formerly separate continental and mocrocontinental fragments offer potential explanations for patters of differentiation among regional biotas. With the connections and disconnections of subregions and islands in this region and the types of forest habitats formed during the flacial periods, I set out two alternative predictions as follows: The differentiation in birds will either show (1) that there is no substantial gene flow occuring among subregions and islands, or that (2) it is consistent with the historical connectivity among the subregions and islands. Using mtDNA control and Atpase6 regions of the little spiderhunter (*Arachnothera longirostra longirostra*), the results revealed evidence of substantial gene flow between the Peninsular Malaysia and Borneo populations. Such level of gene flow was indicated by the sharing of common haplotypes between these subregions and low levels of nucleotide divergence. Conversely, my results suggest low gene flow between Thailand population and the joint Peninsular Malaysia – Bornean populations, as indicated by lack of shared common haplotypes. At higher phylogenetic level, the rate of sequence divergence between little spiderhunter subspecies is concordant with the historical land connections and separations during glaciation periods. The sequence analysis revealed that subspecies *A.I. flammifera* (Mindanao) has diverged from the other two subspecies, *A.I. longirostra* (Peninsular Malaysia and Borneo) and A.I. dilutor (Palawan) approximate to that of the other species (*A. crassirostris* and *A. affinis*). Overall, therefore, the study did not support the hypothesis that neutral genetic divergence accumulates according to a distance model. Instead, the results suggest that avian populations are most likely to be derived from multiple ancient refugia. The "gallery" forests which formed along the North sunda river and its tributaries during glaciation period seem to be most likely locations of these historical refugia.

Researchers:
Mustafa Abdul Rahman, M.T. Abdullah, and Andrew Alek Tuen

Funding:
Unimas Research grants

Related Publications:

Rahman, M. A., and M. T. Abdullah. 2002. Notes on birds and mammals in a limestone forest of Banggi Island, Sabah, Malaysia. Malayan Nature Journal 56(2): 145-152

Rahman, M. A., M. T. Abdullah, and Z. Z. Abidin. 2002. The avifauna of Upper Rejang, Malaysia. Sarawak Museum Journal 57: 237-251.

Redzuan, S., M. A. Rahman, and C. Leh. 2003. Analysis of external morphological characters in determining sexual differences in the Bulbuls (Family: Pycnonotidae). Sarawak Museum Journal LVIII(79): 199-211

INVENTORY AND BIODIVERSITY OF THE FROG FAUNA OF EAST MALAYSIA (BORNEO) WITH EMPHASIS ON THEIR LARVAL FORMS (AMPHIBIA: ANURA)

Larva of *Fejervarya cancrivorus*

Larva of *Leptobrachella mjobergi* (Photo: A. Haas)

Leptophryne borbonica

A new species of *Rhacophorus* from Gading

Although amphibians of Borneo have received attention in the recent past, knowledge of larval stages is patchy, and a large number of species have unknown larval stages. Tadpoles are ecologically and morphologically decoupled from the adult stage due to the extreme metamorphosis known from any amphibian group.

This three-year project, being undertaken under a collaborative project between UNIMAS and Hamburg University (Co-Principal Investigator: Prof. Alexander Haas) sets to collect ecological, biogeographic, and phylogenetic data of Borneo's frogs and especially, the tadpole fauna.

A reference collection is being established, and the database will include genetic identification of species (DNA taxonomy), to allow unequivocal association between larvae and adults.

Data from field-work will be archived in an illustrated database on the tadpoles of Borneo including an identification key. The database is intended to ultimately lead to a book on the tadpoles of Borneo.

Researcher
Indraneil Das

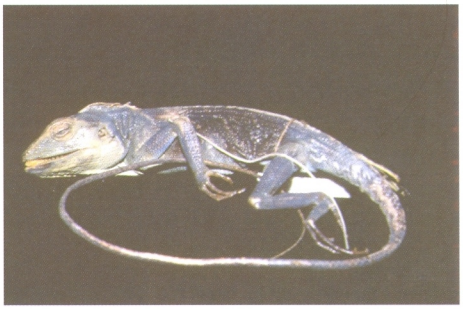
Research Grant
Volkswagen-Stiftung Grant no: 1/79 405

Related publications

Das, I. 2005. A new species of *Rhacophorus (Anura: Rhacophoridae)* from Gunung Gading, Sarawak. Raffles Bulletin of Zoology 53(1). (I. Das & A. Haas.)

In prep. The derived cranial morphology of the burrowing tadpole, *Leptobrachella mjobergi* Smith, 1925 (*Lissamphibia: Anura*). Journal of Morphology (A. Haas, S. Hertweg & I. Das.)

THE HERPETOFAUNA OF SARAWAK'S GUNUNG MURUD, NORTH-WESTERN BORNEO



Gonocephalus mjobergi (BMNH RR 1946.8.13.87; holotype)

New species of *Polypedates* from Murud

Trail to summit of Gunung Murud

Gunung Murud, at 2,423 m, is the highest mountain in Sarawak. The earliest zoological collections here were made by Eric Mjöberg (1882–1938) of the Sarawak Museum. These mountains were to be visited nearly 80 years later, during the present series of expeditions.

Under an IRPA project (grant holder: Dr. Fatimah Abang), we are undertaking inventories of the biotic diversity of Murud. The herpetofauna collected during two expeditions include topotypic material from the Mjöberg Expedition, as well as a number of species new to science. These include members of the genera Polypedates, Pelophryne and Megophrys. As a result of these collections, the known herpetofauna of Borneo is predicted to increase dramatically. Additionally, a number of species hitherto known from Gunung Kinabalu, Sabah, were found. More intensive sampling is planned for Murud within the auspices of the current project.

Researcher
Indraneil Das

Research Grant
Intensification of Research in Priority Areas Grant (grant number: 08-02-09-10007-EA0001).

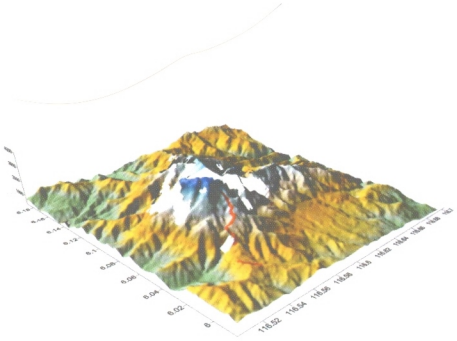
Related publications

Das, I. 2005. *Rhabdophis murudensis* (Gunung Murud Keelback). Diet. Herpetological Review 36(2): in press. (I. Das & A. A. Tuen.)

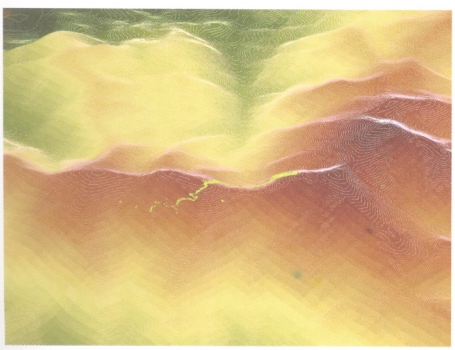
Submitted. A new species of *Polypedates (Anura: Rhacophoridae)* from Gunung Murud, Sarawak (Borneo). Raffles Bulletin of Zoology.

In prep. Elevational distribution of amphibians and reptiles from Gunung Murud, Sarawak, north-western Borneo. Journal of Biogeography.

SYSTEMATICS, BIOGEOGRAPHY AND ECOLOGY OF THE MONTANE HERPETOFAUNA OF MALAYSIA



Gunung Kinabalu, showing transect



Bukit Larut, showing transect

Malaysia supports a highly diverse herpetofauna (> 220 species of amphibians and > 350 species of reptiles). Altogether, they represent a panoply of evolutionary history and diversity, from ancient groups restricted to mountain-tops, to modern ones represented by diverse lineages.

Data were collected through field work and from museum specimens. The resulting database permits studies on distribution, including association of species to habitat types and analysis of interspecific and other ecological relationships, including sympatry, parapatry and allopatry, association of individual species to environments, from the scale of microhabitats to biogeographic units. The edited data can be upgrading as new data on systematics and distribution comes in, superimposed on other data type, such as vegetation and soil types and climatic regimes, and subsequent analysis for trends in the micro- and macrolevel distribution patterns. The resultant analysis has the potential to reveal the best climatic predictors of the distribution of individual species, essential for conservation and management. The distributional and ecological data generated will be of value in land-use planning, conservation of particular taxa and for understanding ecological processes.

Researcher
Indraneil Das

Supporting grant
Universiti Malaysia Sarawak Fundamental Grant, number: 01/59/376/2003 (113)

Related publications
Das, I. 2003. Two new species of *Cnemaspis Strauch*, 1887 (*Sauria: Gekkonidae*) from the Seribuat Archipelago, Pahang and Johor States, West Malaysia. Herpetologica 59(4): 546–554. (I. Das & L. L. Grismer.)

Das, I. 2004. A pocket guide. Lizards of Borneo. Natural History Publications (Borneo) Sdn Bhd. Kota Kinabalu. 83 pp.

QUANTIFYING AND PREDICTING THE EFFLUENT EFFECTS OF A COAL-FIRED POWER PLANT ON THE DENSITY OF MEIO-MACROBENTHOS COMMUNITY

Multiple Regression Prediction Model

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + ... \beta_k x_k + \varepsilon.$$

Table 3: Summary of the multiple regression analyses.

Dependent Variable	Multiple Regression Equation	R-square
Meiobenthos (MEIOS)	MEIOS = 2409.09 - 152.47(DO) - 74.27(SAND)	0.568
Macrobentos (MACRO)	MACRO = 92.073 -7.782(TEMP) + 7.402(TEMPSF) + 27.743(TURB) - 4.624 (SAND)	0.760
Meio-macrobentos (BENTOS)	BENTOS = 2131.463 -17.447(TEMP) - 61.703(SAND)	0.539

The main objective of this study is to quantify and predict the impact of physico-chemical and biological parameters, especially temperature, on the density of meio-macrobenthos community under the effluent effects from the power plant, at Kampung Gobeilt, Sarawak River. The physico-chemical parameters were temperature (water surface and at sample depth), pH, salinity, dissolved oxygen, turbidity, percentage of sand, percentage of mud, total organic matter and chlorophyll a content. The various taxa of meiobentos and macrobentos were identified and quantified in term of their density. Hierarchical multiple regression analyses were used, with meio-macrobentos densities as dependent variables and the physico-chemical and biological parameters as independent variables. Any violations against the assumptions for multiple regression were also highlighted. For meiobenthos, regressed parameters are dissolved oxygen (DO) and percentage of sand (SAND) (R2 = 0.568). It is interesting to note that temperature was not a predicting variable. For macrobenthos, the independent variables are temperature (both the water temperature (TEMP), surface water temperature (TEMPSF)), turbidity (TURB) and percentage of sand (SAND) (R2 = 0.760). The variable temperature is strongly represented for macrobenthos, with both temperature measurements being represented as the predicting variables. For meio-macrobenthos as a whole, the independent parameters are water temperature (TEMP) and percentage sand (SAND) (R2 = 0.538). As expected, the predicting variable of temperature is the limiting variable in the overall prediction of meio-macrobentos. Also noted is the strong presence of the variable, percentage of sand (SAND) in all the 3 prediction equations. The density of meio-macrobenthos also increased in the stations further from the source of the effluent. Several meio-macrobenthos taxa such as the juvenile *Decapoda, Gastropoda, Foraminirera* and *Bivalve* larvae were not found in the stations near to the source of effluent, most likely due to the influence of temperature. These taxa have the potential to become biological indicators in Kampung Gobeilt to detect thermal pollution from the Coal-Fired Plant.

Researchers:
Charlie J. Laman, Shabdin Mohd. Long, and Juliana Jamain

Supporting grant:
Unimas Fundamental Grant

Related publication:
Laman, C. J., Shabdin M. L., and Juliana J. (2003). Quantifying and Predicting the Effluent Effects of a Coal-Fired Power Plant on the Density of Meio-Macrobenthos Community. Proceedings of Conference on National Resources, Environment and Development (NARED2003), Faculty of Resource Science and Technology, Unimas.

FISH FAUNA OF LOAGAN BUNUT NATIONAL PARK: STATUS, THREATS AND MANAGEMENT STRATEGIES

Loagan Bunut was gazetted as a National Park on 29 August 1991. The park covers an area of approximately 10,736 hectares. The lake is situated at the center of the park and it lies between Sg. Tinjar and Sg. Teru. It is the biggest natural inland lake in Sarawak and covers an area of about 6.5 km2. This study aims to record the fish fauna of the Loagan Bunut National Park and to obtain baseline information on the fishing activities taking place in the area. Surveys on the fish fauna of Loagan Bunut and its tributaries, Sg. Tinjar and Sg. Teru were carried out in June 2003 during low water level, July 2003 during mid water level and April 2004. Sampling methods that were employed include gills nets, cast nets, scope net, and hooks and lines. Fish samples were also obtained from fulltime fishermen operating a trap net (locally known as selambau). In this study, a total of 70 species of fish from 22 families were recorded from Loagan Bunut National Park area. The park is an important fishing ground, and people who live in the park area including the Long Teru inhabitants are dependent on the fish from the park area as a source of protein and income. The area is also an important spawning, nursery, refuge and feeding area for freshwater fish. Therefore, it is very important to conserve the environmental conditions of the area within and outside the park. Threats to the fish fauna in the area include unsustainable fishing methods, over fishing, better accessibility to the area, land use outside the park, and land use within the park. There is an urgent need for habitat conservation and regulation of fishing activities in order to ensure the diversity of fish species is maintained and fisheries in the area are sustainable. Some of the countermeasures needed to mitigate the threats include the introduction of regulation to control minimum gill net mesh size, prohibition of fishing activities during low water level at nursery areas, prohibition on the use of trap (selambau) during spawning migration, licensing system to report the quantity of catch by species to the park, and the introduction of a buffer zone along major rivers and tributaries.

Researchers
Lee Nyanti, Gabriel Tonga Noweg (Unimas) and Alexander Sayok (GEF/UNDP).

Supporting grant
GEF/UNDP Contract No. MAL/99/G31; Unimas Fundamental Grant No. 01(97)444/2004(181).

Related publications

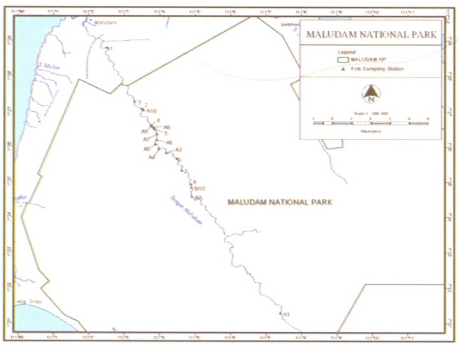
Burke, M.G. 1978. Longhouse Survey, Lake and Riverine Fisheries Development Project, Baram District, Fourth Division, Sarawak, Malaysia. A report submitted to the Department of Agriculture, Sarawak. pp. 47-51.

Inger, R.F. and P.K. Chin. 1990. The fresh-water fishes of North Borneo. Sabah Zoological Society, Kota Kinabalu. 268 p.

Kottelat, M., A.J. Whitten, S.N. Kartikasari and S. Wirjoatmodjo. 1993. Freshwater fishes of Western Indonesia and Sulawesi. Periplus Editions Ltd., Jakarta.

Mohsin, A.K.M. and M.A. Ambak. 1983. Freshwater fishes of Peninsular Malaysia. Universiti Pertanian Malaysia, Serdang. 284 p.

FISH FAUNA OF MALUDAM NATIONAL PARK



One of the most neglected and least studied of all the kinds of freshwater habitats present in Borneo are the peat swamps. With tea colored water-ladened substrate formed of slowly decaying vegetation low in oxygen levels, low in calcium concentrations and high acidity, peat swamps are a very extreme habitat for any organism. Fish living in the blackwaters of peat swamps remain poorly studied. The Maludam peat swamp forest is the largest patch of peat swamp forest in Sarawak with an area of 43,147 ha. The area was gazetted by the Sarawak Government as a National Park in 2000. The park is almost equally divided in the middle by Maludam River. The 28 km Maludam River runs almost in a straight line from the southeast to the northwest without any major tributaries along the river. A survey on the fish fauna of Maludam National Park was carried out in October 2001 and August and October 2002. Fish were caught using various types of hooks and lines, trap net (*bubu*), bag net (*selambau*) and electrofishing. A total of 11 families of fish consisting of 28 species were caught from Maludam National Park. The relatively low number of fish species caught from Sg. Maludam is typical of the peat swamp environment. One species of the Asian soft shell turtle (*Amyda cartilaginea*) was also caught from the study area. In terms of the number of individuals caught, 38% were from the family Cyprinidae, 21% from the family Channidae, 15% from the family Siluridae and 11% from the family Clariidae. The dominance of the cyprinid species is typical for not only Sg. Maludam but also other rivers in Sarawak. Within the family cyprinidae, 63% of the individuals caught were from the species *Rasbora einthovenii* and *R. elegans*. *Channa lucius* made up 63% of the individuals within the family Channidae, *Wallago leerii* and *W. maculatus* made up 60% of the individuals within the family Siluridae, *Clarias teysmanni* made up 37% of the individuals within the family Clariidae. There are no commercial riverine fisheries taking place in Sg. Maludam. Most of the fishing activities in the river are performed by the residents of the two longhouses (a total of 13 doors) and are almost entirely for their own consumption. Market demand for freshwater fishes in Maludam town is also low because of the widely available marine fishes. These factors were the reasons for the existence of sustainable riverine fisheries in Sg. Maludam. In Sg. Maludam, the annual spawning activities for most fish species occur in the months of September to early December. Peak spawning activities were reported to occur in October and early November.

Researchers:
Lee Nyanti (Unimas) and James Bali (Sarawak Forestry Coporation).

Supporting grant:
Joint Working Group Netherlands-Malaysia: The Development and Management of Maludam National Park.

Related publications:

Eddy, S.P.T., L. Nyanti, S.M. Long, N. Ismail, F. Abang, B. Chernoff and P.K. Chin. 1995. Aquatic Resources of Batang Balui. A report on the environmental impact assessment of the Bakun Hydro-electric project submitted to the Natural Resources and Environmental Board, Kuching, Sarawak.

Inger, R.F. and P.K. Chin. 1990. The fresh-water fishes of North Borneo. Sabah Zoological Society, Kota Kinabalu.

THE IMPACT OF INTRODUCED SPECIES (NON-NATIVE & EXOTIC) ON THE GENETIC DIVERSITY OF NATIVE FRESHWATER FISHES IN MALAYSIA

Tilapia *(Oreochromis spp)*

African Catfish *(Clarias gariepinus)*

This study examines the impact of introduced freshwater fish species (non-native and exotic) on several native freshwater fishes in Malaysia using ecological and molecular genetics approaches. Native fish species have greatly been reduced in numbers throughout the world, or even destroyed/extinct, partly as a result of non-native and/or exotic species been introduced into their native habitats. Introduced species, are seen as competing or preying on native species or destroying their habitats. Introduced species (or subspecies), however, can generate another kind of extinction, a genetic extinction by hybridization and introgression with native species. Many exotic species imported or brought has dominated the fish culture industry in our country. Some of these species have been released into natural habitat such as rivers and lakes or into man-made paddy fields, mining pools or dams and, unfortunately, we don't have any information on their effects on our native freshwater fauna. Some of the cultured fish may escaped or accidentally been released into the natural habitat as a result of flooded during monsoon seasons. In addition, habitat modification resulted from human disturbance (deforestation, construction of hydroelectric dams etc) can also break down reproductive isolation between native species, with subsequent mixing of gene pools and potential loss of genotypically distinct populations.

This study aim to determine the impact of introduced species in Malaysian freshwater systems on the ecology, genetic diversity and integrity of several native freshwater fishes. The project output will provide information for conservation management plan to protect Malaysian freshwater fauna from further devastation through fish introduction.

Researchers

Yuzine Esa and Khairul Adha A. Rahim

Supporting grant

ASEAN, Regional Centre for Biodiversity Conservation (ARCBC)

Related publication

Esa Y.B and Khairul Adha A. Rahim, 2003.The Impact of Introduced Species (Non-Native and Exotic) on the Genetic Diversity of Native Freshwater Fish in Malaysia. Final Report submitted to ASEAN Regional Center for Biodiversity Conservation, Los Banos, Philippines. 166pp.

GENETIC ANALYSIS OF THE IMPACT OF INTRODUCED SPECIES (NON-NATIVE AND EXOTIC) ON NATIVE FRESHWATER FISHES IN MALAYSIA

The project applied molecular genetics techniques in conjunction with ecological studies to examine the impact of several introduced freshwater fishes such as *Oreochromis niloticus* (Nile tilapia), *Barbonymus gonionotus* (Lampam jawa), and *Helostoma temminckii* (Tebakang or Biawan) on the genetic variability and ecology of native freshwater species. Through molecular approaches (sequencing of mitochondrial genes), the project investigated the systematic relationship (hence taxonomic status) between closely related introduced (in most case non-native) species and native/indigenous counterpart. Subsequently, population structure analyses were done to determine and compare the level of genetic diversity between introduced versus native species. The project also identified a few genetic markers useful for species discrimination between introduced and native species. The project results showed that introduced species exhibited comparables (sometimes higher) genetic diversity compared with native species, although they had recently been introduced in a particular area. Ecological studies showed that introduced species shared macro habitat and diet with native species (competition for foods and breeding grounds). No indication of hybridization (direct genetic impact) was observed between introduced and native species occurred in sympatry (e.g. between *Barbonymus schwanenfeldii* and *Barbonymus gonionotus*). Overall, all introduced species studied in the project have adapted well to the local environment and even dominated the particular habitat where the have been introduced (i.e. *Helostoma temminckii* in blackwater areas in Sarawak). The current ecological (food habit and macro habitat studies) and molecular (genetic diversity) analysis both pointed towards the potential of the introduced species to create negative impact (indirect genetic impact) on the viability of native/indigenous species. Although the genetic impact was not categorized as a serious threat but long term impact must be avoided by implementing appropriate management plan for both introduced as well as native species.

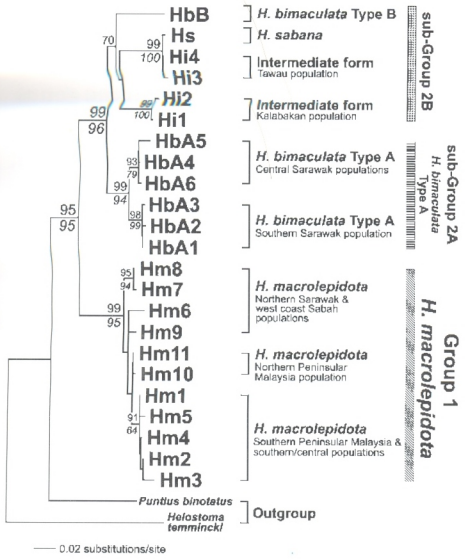
Researchers
Yuzine bin Esa (Project Leader) and Khairul Adha A. Rahim

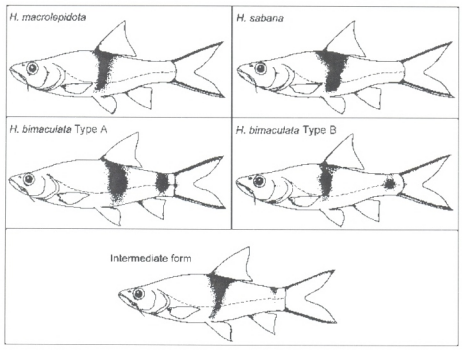
Research Funding
ARCBC grant RE-MYS-002

Related Publication

Esa Y.B and Khairul Adha A. Rahim, 2003.The Impact of Introduced Species (Non-Native and Exotic) on the Genetic Diversity of Native Freshwater Fish in Malaysia. Final Report submitted to ASEAN Regional Centre for Biodiversity Conservation (ARCBC), Los Banos, Philippines. 166pp.

PHYLOGENETIC ANALYSIS OF FRESHWATER FISHES OF THE GENUS *HAMPALA* (CYPRINIDAE) IN BORNEO





Fish of the genus *Hampala* (Cyprinidae) is an interesting candidate for phylogeographic study of Borneo Island. The taxonomy and systematic status of species within the genus *Hampala* is still problematic with current classification rely solely on classical method such as morphological and behavioural characters. Indeed, *Hampala* shows much geographic variation in coloration and fin ray counts. Morphological study has identified two species in Borneo; the common *Hampala macrolepidota*; which can be found throughout SouthEast Asia and a Bornean endemic *Hampala bimaculata*. Interestingly in North Borneo, Inger and Chin (1962) characterize and recognized three subspecies based on morphology; *H. macrolepidota bimaculata* in the west-coast region, *H. macrolepidota sabana* in the Labuk-Segama region, with an intermediate form (undescribed subspecies) in the Tawau region. Phylogenetic analysis revealed the reciprocally monophyletic status of *Hampala macrolepidota* from the other *Hampala* forms, thus strongly supporting its status as a distinct species. Phylogenetic analysis also discovered the existence of two *Hampala bimaculata* lineages endemic to Borneo: (1) a newly identified species from southern and central part of Sarawak assigned as *Hampala bimaculata* Type A and (2) the previously described *Hampala bimaculata* from northern Sarawak and west coast of Sabah assigned as *Hampala bimaculata* Type B. However, the status of *Hampala sabana* and the intermediate form could not be elucidated yet. Our results suggest that the intermediate form from the Tawau population is actually a subpopulation of *Hampala sabana* while the highly divergent intermediate form from Kalabakan could represent a cryptic species. Our results also suggest that the speciation of all *Hampala* forms could have occurred as early as the Pliocene period. The sharing of *H. macrolepidota* haplotypes in the southern Peninsular Malaysia and the southern/central Sarawak samples (Hm1 and Hm2) reflected the recent disconnection of the two regions, during the last Pleistocene periods. Overall, the partial sequencing of the *cytochrome* b mitochondrial DNA region was useful for resolving the phylogenetic relationships among *Hampala* fishes in Malaysia.

Researchers

Yuzine bin Esa and Jeffrine Rovie Japning

Supporting Grant

Unimas Short Term Grant 245/2001(4)

Related Publications

Japning, JRR and Esa, YB (2003). Phylogenetic analysis of *Hampala* (Cyprinidae) in Sarawak using *cytochrome* b mtDNA region. In: Natural Resources, Environment and Development (NARED) Conference. Kuching, Sarawak. 24-27 September 2003.

Esa, YB; Kamaruddin, KR; Japning, JRR and Khairul Adha A. Rahim (2003). Phylogenetic analysis of several indigenous freshwater fishes in Malaysia inferred from sequencing analysis of *cytochrome* b mtDNA gene. In: Natural Resources, Environment and Development (NARED) Conference. Kuching, Sarawak. 24-27 September 2003.

GENETIC DIVERSITY AND IDENTIFICATION OF MOLECULAR MARKERS IN THE ENDANGERED *TOR* FISH (*CYPRINIDAE*) IN SARAWAK

The genus *Tor* (Gray) belongs to the family *Cyprinidae* (subfamily Cyprininae). There are currently three described species in the genus based on non-genetic classification; *Tor tambroides* (Bleeker), *Tor douronensis* (Valenciennes) and *Tor tambra* (Valenciennes). However, morphological identification of *Tor* are difficult and sometimes unreliable, due to their high variations in coloration and local names, thus making molecular approaches very important for rapid genetic identification of species in the genus. Environmental disasters (i.e. river pollutions, deforestation, watershed erosion etc) had led to the rapid destruction of their natural habitat. In addition, overfishing of the fishes had greatly reduced their population size. Their distributions are now limited to the upper streams and protected areas of Peninsular Malaysia and Borneo. Thus, realizing the importance of the genus as food and recreational fishes, and given their limited distributions, a comprehensive study on their systematic and population genetic structure, are highly required in order to determine their genetic relationships and levels of genetic variations in all existing species of the genus in Malaysia. Phylogenetic study will be able to assign the genus into conservation unit: Management Unit (MU) for genetically distinct populations within the same species, and Evolutionary Significant Unit (ESU) for genetically distinct/reciprocally monophyletic taxa. Hence, this study will shed light on the validity of current taxonomic and systematic classifications of the genus from the genetic viewpoint. Population genetics study will elucidate the contemporary genetic structure of the genus through studies of gene flow and levels of genetic variations. Overall, the study will aim to provide baseline genetic information useful for management authorities to develop conservation/management plan for protection of the genus. Our preliminary genetic analysis shows that three *Tor* froms following their local names (Semah from Sarawak, Belian from Sabah, and Kelah from Peninsular Malaysia) formed distinct monophyletic clusters between them. The Belian fish was genetically more closely related to the Semah (3.2-6.1% sequence divergence) compared to the genetic differences between Belian and Kelah fish (6.6-7.1%) and between Semah and Kelah (6.2-8.9%). More molecular results are underway to further elucidate the systematic relationships and population structure of *Tor* fishes in Malaysia.

Researchers
Yuzine bin Esa and Khairul Adha A. Rahim

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Related Publication:
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